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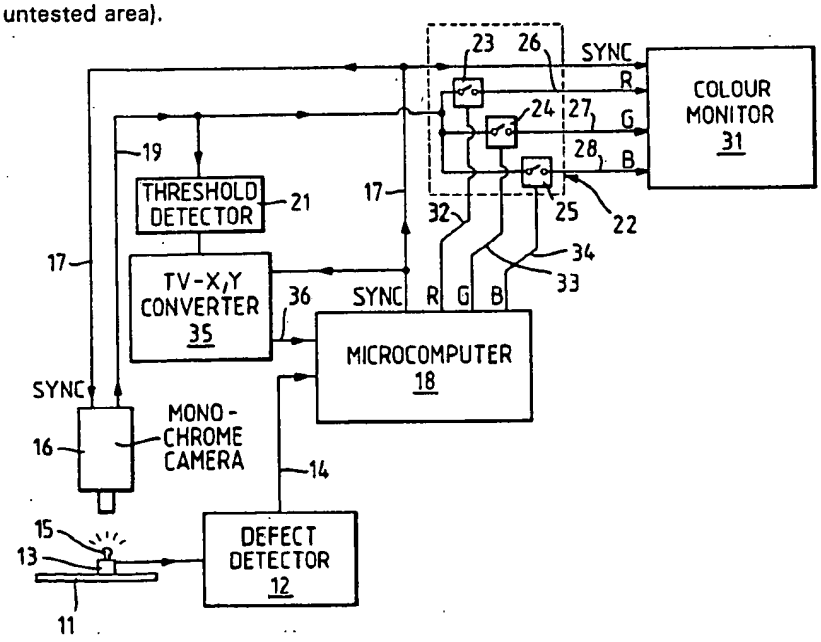
Selected US specifications from IPC sub-class H04N

(54) Superimposition in a video display system

(57) A signal is generated for producing a video display of superimposed images, one of which is derived from a system for detection of non-visual signals, such as an ultrasonic inspection system 12,13 whilst the other is a television image produced by video camera 16. Accurate registration of the superimposed images is achieved by providing a movable probe 13 of the ultrasonic inspection system indicating the location of inspection with a point source 15 of light or other radiation to which the video camera responds. During each raster scan of the video camera the position of the point source is registered and data, representing the response of the detector system, stored in a memory system. An output from the memory system is combined 22 with the camera video signal to produce the superimposed images. When the probe indicates that test piece 11 is O.K, only switch 24 is closed giving a green image, but at points where the test piece is defective only switch 23 is closed giving a red image (as opposed to a black and white image for untested area).



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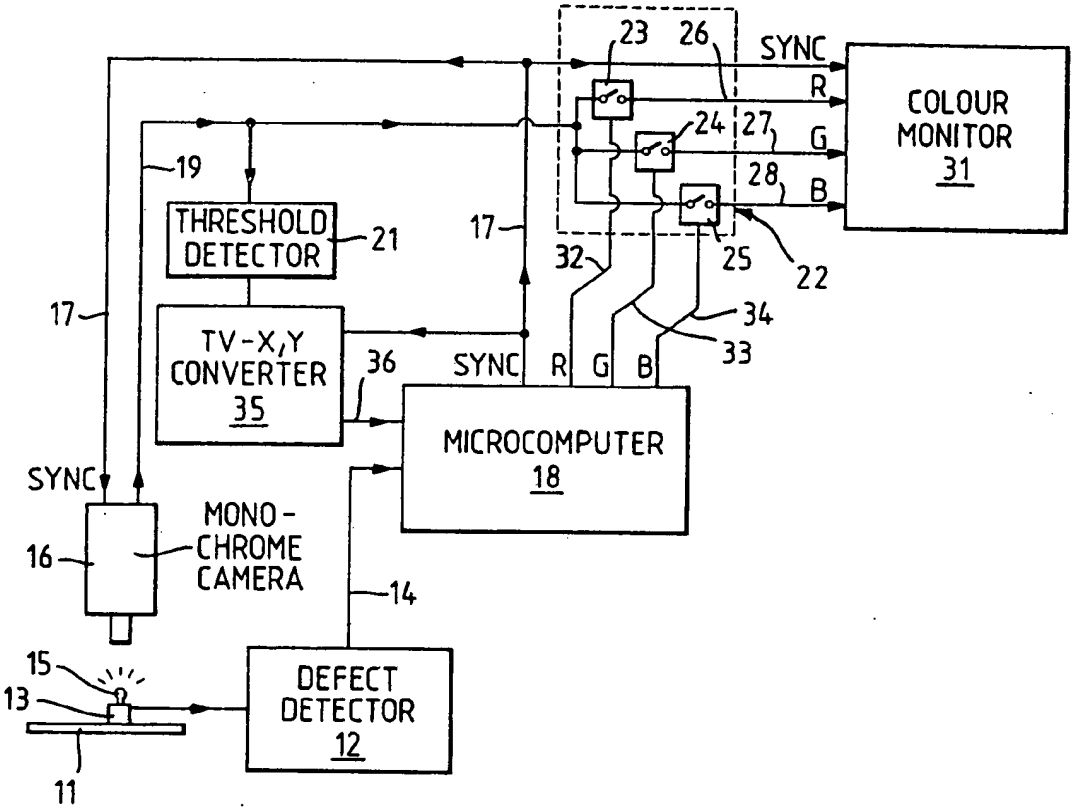
23
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SYNC
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COLOUR MONITOR 31
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THRESHOLD DETECTOR
21
17
32
34
33
TV-X,Y CONVERTER 35
36
SYNC
R
G
B
MICROCOMPUTER 18
SYNC
MONO-CHROME CAMERA
16
14
15
13
DEFECT DETECTOR 12
11

SPECIFICATION

Sup rimposition in a video display system

The invention relates to apparatus for providing a video display in which an image derived from one or more detector systems is superimposed upon a visual image derived from a camera.

In this way a user of the apparatus can be assisted by relating the output of a non-visual signal detector device to the visual appearance of the image produced by the camera of an object under test.

Whilst highly sophisticated image processing and handling techniques are available using computers or microprocessors, a problem with the type of image superimposition referred to above is that of registering one image in its proper relationship and scale with the other.

One solution to this problem is disclosed in GB 2 136 242 according to which apparatus is provided for generating a video display signal capable of driving a suitable imaging system to produce superimposed images from two or more detector systems, which apparatus comprises a camera, one or more detector systems, the or at least one of the detector systems including a movable probe, a source on the probe, the position of which source is indicative of the position of investigation of the associated detector system, and which source produces light, or other radiation to which the camera responds, in excess of a predetermined intensity whenever the detected signal of the said associated detector system has a predetermined characteristic, the camera producing, when trained upon an area including the said position of investigation, a video signal including that produced by the light or other radiation from the said source on the probe, a threshold detector for detecting whenever light or said other radiation received by the camera exceeds the said predetermined intensity, a memory system scanned in synchronism with the video signal from the camera and arranged to store the video signal at all positions where the said predetermined intensity is exceeded, and means for mixing video signals from the memory system with the video signals from the camera so that the mixed signals when fed to an imaging system are displayed as the visual image seen by the camera with superimposed bright points at all positions on the image where the said predetermined intensity has been exceeded.

The present invention is a development of that described in GB 2 136 242 and provides apparatus for generating a vide display signal capable of driving a suitable imaging system to produc superimposed images, which apparatus comprises a video camera, on or more detector systems, the on or at least one of the detect r systems including a movable probe, a source on the probe, the position of which source is indicativ of a position of investigation of the associated detector system, and which source produces light, or oth r radiation to which the camera responds, having a distinguishing characteristic, the camera producing, when trained upon an area including the said position of investigation, a video image signal including that produced by the light or other radiation from the said source on the probe, a memory system, means for scanning of the memory system in synchronism with the video image signal, means responsive to the said distinguishing characteristic for providing identification of the address in the memory system of the position of the probe, means operative independently of the said distinguishing characteristic under control of the detector system for causing the memory system to store at the said identified address a representation of detector system output at the position of the probe corresponding with the said identified address, and means for combining video image signals from the camera with video signal elements derived from the memory system so that the combined signals when fed to an imaging system are displayed as the visual image seen by the camera with superimposed picture elements representative of detector system output at positions of investigation of the probe.

The said means under control of the detector system may trigger the memory system whenever output from the detector system has a predetermined characteristic to store at the said identified address in the memory system corresponding with the position of the probe data representing a predetermined video signal element, so that the said combined signals when fed to an imaging system are displayed as the visual image seen by the camera with superimposed predetermined picture elements at all positions of investigation of the probe at which the detector system has produced output having the said predetermined characteristic.

In this way, using a camera which responds to visible light and a light source on the probe, it is possible to scan the probe over an object and build up an array of bright points superimposed upon the ordinary visual image of the object, the bright points corresponding with some predetermined characteristic under investigation. Thus for example, the detector system may be as described in British Patent Specification No 2044198 in which backscattered penetrating radiation is detected, for example neutrons to reveal low at mic number material concealed behind steel.

There may be additional detector systems each including a probe with a light source thereon. In this case it is desirabl to distinguish on det ctor system from another by using different coloured light sourc s on the probes. Further, the indication of the response

of a single detector system may be sub-divided by providing on the probe a plurality of light sources distinguishable from one another by differences in colour. It is also possible for certain applications that display may be wanted of only the images produced by scanning the probes of two or more detectors without including display of the visual scene. In this case the camera would be set to respond only to the brightness of the light sources on the probes and to produce no image from other sources of light.

In one arrangement according to the invention the said distinguishing characteristic is provided by an intensity of the light, or said other radiation, in excess of a predetermined intensity. In this case, the said means responsive to the distinguishing characterstic includes a threshold detector. It will be appreciated that, to avoid false indications of probe position, the intensity of the light, or said other radiation, from the source has to exceed that from any other object within the scene observed by the camera.

In another arrangement according to the invention the said distingishing characteristic is provided in that the light, or said other radiation, from the source is flashing or modulated in a predetermined manner, and the said means responsive to the distinguishing characteristic responds to the said flashing or modulation.

Conveniently, the said predetermined video signal element has one characteristic, for example for a green coloration, when the output from the detector system has one characteristic, for example indicative of no defect, and the said predetermined video signal element has another characteristic, for example for a red coloration, when the output from the detector system has another characteristic, for example indicative of the presence of a defect. Where a detector system is capable of providing a range of output signals indicative of a corresponding range in the property to which the detector system responds, then a corresponding range of characteristics, for example in the form of a grey scale, of said predetermined video signal element may be generated.

Preferably the memory system and the said means for scanning of the memory system compromise a microcomputer. Synchronism with the video camera is achieved by connecting a synchronising signal output from the microcomputer to a synchronising signal input on the camera, so as to drive the camera scan in synchronism with the video display signal generator of the microcomputer.

A specific construction of apparatus embodying the invention will now be described by way of example and with reference to the drawing filed herewith, which is a block circuit diagram of the apparatus.

The drawing shows a system for superimposing on an image of a visual scene an image produced using a detector of non-visual signals, in this example an ultrasonic inspection system.

A sample under inspection is represented at 11. A conventional ultrasonic inspection system 12 has a probe 13 and provides an output signal on line 14. In a simple arrangement, this output signal is digital having one level (1) when the system detects a defect within the region of inspection and another level (0) when no defect is detected.

The probe 13 is modified for the purpose of the present example by mounting thereon a point source of light 15 which is switched permanently on for the duration of a test.

A monochrome video camera 16 is provided with synchronising signals on line 17 from a microcomputer 18. The output signal from the camera 16 representing the intensity of each pixel in the raster scan sequence is fed via line 19 to a threshold detector 21 and to a network 22 by which the monochrome intensity signal is applied via solid state switches 23, 24, 25 to three lines 26, 27, 28 connected respectively to the RGB (red, green, blue) inputs of colour monitor 31. As will become clearer from the following description, the synchronising signal from line 17 together with RGB on lines 26, 27, 28 all connected to the colour monitor 31 provide a composite colour video image signal input in a standard format to the colour monitor 31.

The solid state switches 23, 24, 25 are controlled respectively by the RGB output from the microcomputer, shown as lines 32, 33, 34. The associated switch 23, is closed when the line 32, carries a signal and open when the signal is at a predetermined low level. Switches 24, 25 operate in the same way from the signal levels on lines 33 and 34 respectively.

A television to X-Y converter 35 is provided for generating X,Y coordinates representing position for the microcomputer memory system from the television raster scan signal. A synchronising signal for the converter 35 is provided on line 17 and output signals on line 36 to the microcomputer 18 combined with those on line 14 from the ultrasonic inspection system provide data input to the microcomputer 18. Operation of the converter 35 is under control of the threshold detector 21.

In operation, the intensity of light from the source 15 is set at a level exceeding that from any other object in the field of view of the camera 16.

Initially, all the solid state switches 23, 24, 25 are closed so that the monitor 31 displays a black and white picture corresponding with the visual scene observed by the camera 16. However, as the camera scan takes in the image of the point source 15, the light intensity is such that the signal level on line 19 exceeds the threshold set in threshold detec-

tor 21. This triggers converter 35 to supply to the microcomputer 18 on line 36 the address of the computer memory location corresponding to the position in the image at that instant of the point source 15.

In this example, the microcomputer 18 is programmed to store at that address data from line 14 in such a form that output signals on the RGB lines 32, 33, 34 from the microcomputer will have the following effect at all subsequent scans until the data at that memory address is changed or reset:

1. if there is no defect signal on line 14, switches 23 and 25 are opened, switch 24 is closed

2. if there is a defect signal on line 14, switches 24 and 25 are opened, switch 23 is closed.

The consequence is that the pixel(s) in the display corresponding to the position of the point source 14 is (are) turned green if there is no defect signal and red if there is a defect signal. If the probe 13 is now moved to make, for example, a scanned inspection of the sample 11, each new position is "painted in" on the display, green showing where inspection has been carried out and no defect found, red showing where defects have been found.

In this example the computer is programmed so that if the probe 13 is scanned over a region more than once, green display can be changed to red, but not vice versa. Thus, detection of a defect shows as red on the display even although a previous scan of the same area revealed no defect. However, once a defect has been detected, the associated red display cannot be changed back to green.

It will be appreciated that the arrangement as described will operate with any form of detector system having a binary or on/off output signal characteristic.

However, the flexibility of a microcomputer is readily harnessed to give a more sophisticated capability. Thus a detector system giving a range of six different output signal characteristics is readily accommodated in the arrangement described by switching to generate green, red, blue, red/green, red/blue, green/-blue according to which detector signal characteristic is received.

For example the ultrasonic inspection system 12 has a facility for providing an indication of whether or not the coupling between the probe 13 and the sample 11 is satisfactory. A signal indicating poor coupling can thus b arranged to produce a particular colour as a warning to the op rator showing regions of the sample where th scan should be r peated.

For still greater s phisticati n in which a larger number of detector output signal characteristics is accommodated, then it is necessary to introduc , rath r than simple switching, a mixing of signal intensity from the computer RGB output with that from the video camera.

One problem met on occasion with the apparatus of this example is that the threshold level in the threshold detector 21 is exceeded by the appearance of a bright object, unconnected with the probe 13, in the field of view of the camera 16. A solution is to provide periodic automatic detection of the maximum intensity in the image when the point source 15 is switched off and to reset the intensity of the point source 15, on switching it on again, to a level in excess of that maximum. The threshold detector 21 has, of course, to be reset simultaneously to a level above that maximum and below the new level of the point source 15.

Another solution is provided by a modification in which the point source 15 is made to flash on and off in synchronism with each successive frame scan. The threshold detector 21 is omitted and the microcomputer 18 is programmed to register pixels which switch on and off in phase with the frame scan.

The invention is not restricted to the details of the foregoing example. Other detector systems can be used such as, for example, use penetrating radiation or eddy currents. Indeed, the apparatus can be used with any detector system for which response can be confined to limited areas defined by a probe position or probe and associated point source position.

It may be convenient, as described in GB 2 136 242 to use one or more lenses and/or mirrors to provide a desired apparent or virtual position of the point source.

The arrangement is readily adapted for use with a camera which responds to other than visual radiation. Thus, a camera sensitive to infra-red radiation, for example may be used. Where the camera, as is usual, also responds to visible light, an infra-red emitting diode could be used as the source on the probe. The intensity of the infra-red emitted by the diode would have to be such as to exceed a predetermined reference level. Alternatively, an infra-red camera would clearly enable a general image to be formed of a scene (eg at night) which is not illuminated with visible light but which is emitting infra-red. In that case the source on the probe could also be an infra-red emitting diode or alternatively could be a source of visible light.

The composite video signal output may be recorded on a video recorder for subsequent display via a monitor. The composite video signal may be transmitted over long distances by cable or radio transmission if desired.

In a development, initial setting up of the camera iris and intensity of the s urce on the probe is made easier by additional camera signal output level detectors and software control. Thus, for example, under software contr lled instructions displayed on the screen, the operator is required to adjust the camera

iris, with the probe source off, until th maximum image signal intensity (the brightest object in the visual scene) is greater that 50% and less than 70% of the maximum (saturation) output of which the camera is capable. The probe source is then switched on and its intensity increased stepwise until it produces an output signal intensity at 95% of the camera maximum.

CLAIMS

1. An apparatus for generating a video display signal capable of driving a suitable imaging system to produce superimposed images, which apparatus comprises a video camera, one or more detector systems, the one or at least one of the detector systems including a movable probe, a source on the probe, the position of which source is indicative of a position of investigation of the associated detector system, and which source produces light, or other radiation to which the camera responds, having a distinguishing characteristic, the camera producing, when trained upon an area including the said position of investigation, a video image signal including that produced by the light or other radiation from the said source on the probe, a memory system, means for scanning of the memory system in synchronism with the video image signal, means responsive to the said distinguishing characteristic for providing identification of the address in the memory system of the position of the probe, means operative independently of the said distinguishing characteristic under control of the detector system for causing the memory system to store at the said identified address a representation of detector system output at the position of the probe corresponding with the said identified address, and means for combining video image signals from the camera with video signal elements derived from the memory system so that the combined signals when fed to an imaging system are displayed as the visual image seen by the camera with superimposed picture elements representative of detector system output at positions of investigation of the probe.

2. An apparatus as claimed in claim 1, wherein the said means under control of the detector system trigger the memory system whenever output from the detector system has a predetermined characteristic to store at the said identified address in the memory system corresponding with the position of the probe data representing a predetermined video signal element, so that the said combined signals when fed to an imaging system are displayed as the visual image seen by th camera with superimposed predetermined picture elements at all positions of investigation of the probe at which the detector system has produced output having the said predetermined characteristic.

3. An apparatus as claimed in claim 1 or claim 2, wherein th said distinguishing characteristic is provided by an intensity of the light, or said other radiation, in excess of a predetermined intensity and the said means responsive to the distinguishing characteristic includes a threshold detector.

4. An apparatus as claimed in claim 1 or claim 2, wherein the said distinguising characteristic is provided in that the light, or said other radiation, from the source is flashing or modulated in a predetermined manner, and the said means responsive to the distinguishing characteristic responds to the said flashing or modulation.

5. An apparatus as claimed in claim 2, wherein the said predetermined video signal element has one characteristic, when the output from the detector system has one characteristic, and the said predetermined video signal element has another characteristic, when the output from the detector system has another characteristic.

6. An apparatus as claimed in claim 2, wherein a detector system is capable of providing a range of output signals indicative of a corresponding range in the property to which the detector system responds, and a corresponding range of characteristics of said predetermined video signal element is generated.

7. An apparatus as claimed in any of the preceding claims, wherein the memory system and the said means for scanning of the memory system comprise a microcomputer and synchronism with the video camera is achieved by connecting a synchronising signal output from the microcomputer to a synchronising signal input on the camera, so as to drive the camera scan in synchronism with the video display signal generator of the microcomputer.

8. An apparatus substantially as hereinbefore described with reference to, and illustrated in, the drawing filed herewith.

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